Spring 28/61–11d1 discharging from alluvium in Northern Butte Valley.

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WATER RESOURCES–RECONNAISSANCE SERIES

REPORT 49

WATER–RESOURCES APPRAISAL OF BUTTE VALLEY, ELKO AND WHITE PINE COUNTIES, NEVADA

DESERT RESEARCH INSTITUTE

By

Patrick A. Glancy

Prepared cooperatively by the
Geological Survey, U.S. Department of the Interior

JULY 1968

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FOREWORD

The program of reconnaissance water-resources studies was authorized by the 1960 Legislature to be carried on by the Department of Conservation and Natural Resources in cooperation with the U.S. Geological Survey.

This report is the 49th report prepared by the staff of the Nevada District of the U.S. Geological Survey. These 49 reports describe the hydrology of 148 valleys.

The reconnaissance surveys make available pertinent information of great and immediate value to many State and Federal agencies, the State cooperating agency, and the public. As development takes place in any area, demands for more detailed information will arise, and studies to supply such information will be undertaken. In the meantime, these reconnaissance-type studies are timely and adequately meet the immediate needs for information on the water resources of the areas covered by the reports.

Roland D. Westergard
State Engineer

Division of Water
Resources

July 1968

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WATER-RESOURCES APPRAISAL OF BUTTE VALLEY, ELKO AND WHITE PINE COUNTIES, NEVADA

By Patrick A. Glancy

SUMMARY

Butte Valley includes two topographically closed valleys in east-central Nevada. The valleys, referred to in this report as northern Butte Valley and southern Butte Valley, cover a total area of about 1,000 square miles. Principal hydrologic facts and estimates resulting from this reconnaissance are summarized in table 1.

Precipitation within the area is assumed to be the main source of water supply to the valley-fill reservoir. However, carbonate rocks, which are prevalent in the region, may be highly transmissive locally; therefore, the precise location of recharge boundaries is unknown. For purposes of reconnaissance estimates and calculations, recharge boundaries in most places are assumed coincident with topographic boundaries. However, regional intervalley flow through carbonate rocks may occur.

The principal known aquifers occur in the valley fill at generally shallow depths. However, only about 20 wells have been drilled, and no data are available regarding deeper parts of the valley fill. The carbonate rocks of the area also constitute an unexplored but probably significant ground-water system.

Natural ground-water discharge in the area is mainly by evapotranspiration, which totals almost 20,000 acre-feet per year.

Only five significant perennial streams occur in the area. Characteristics of numerous ephemeral stream channels and the nature of the geologic terrane suggest that mean annual runoff yields of the area are unusually low with regard to precipitation input when compared with most Nevada drainage basins.

Chemical analyses of water from 21 well, spring, and stream sources show very good quality of water in the area. All constituents in the water tested are acceptable for most common purposes requiring good quality of water, based on results of the

constituents investigated; however, detrimental concentrations and constituents may occur that were not determined by the analyses.

Streamflow is used for irrigation but ground-water resources of the area are mainly undeveloped. Surface water and springflow are currently used mainly to irrigate about 2,000 acres of native pasture and alfalfa. Ground-water pumpage for domestic and stock use probably did not exceed 35 acre-feet in 1967. A few springs are used for stock-watering and domestic purposes. Future development may depend principally on whether the quantity of available water is adequate for the intended use and the economic limitations governing the extraction of ground water.

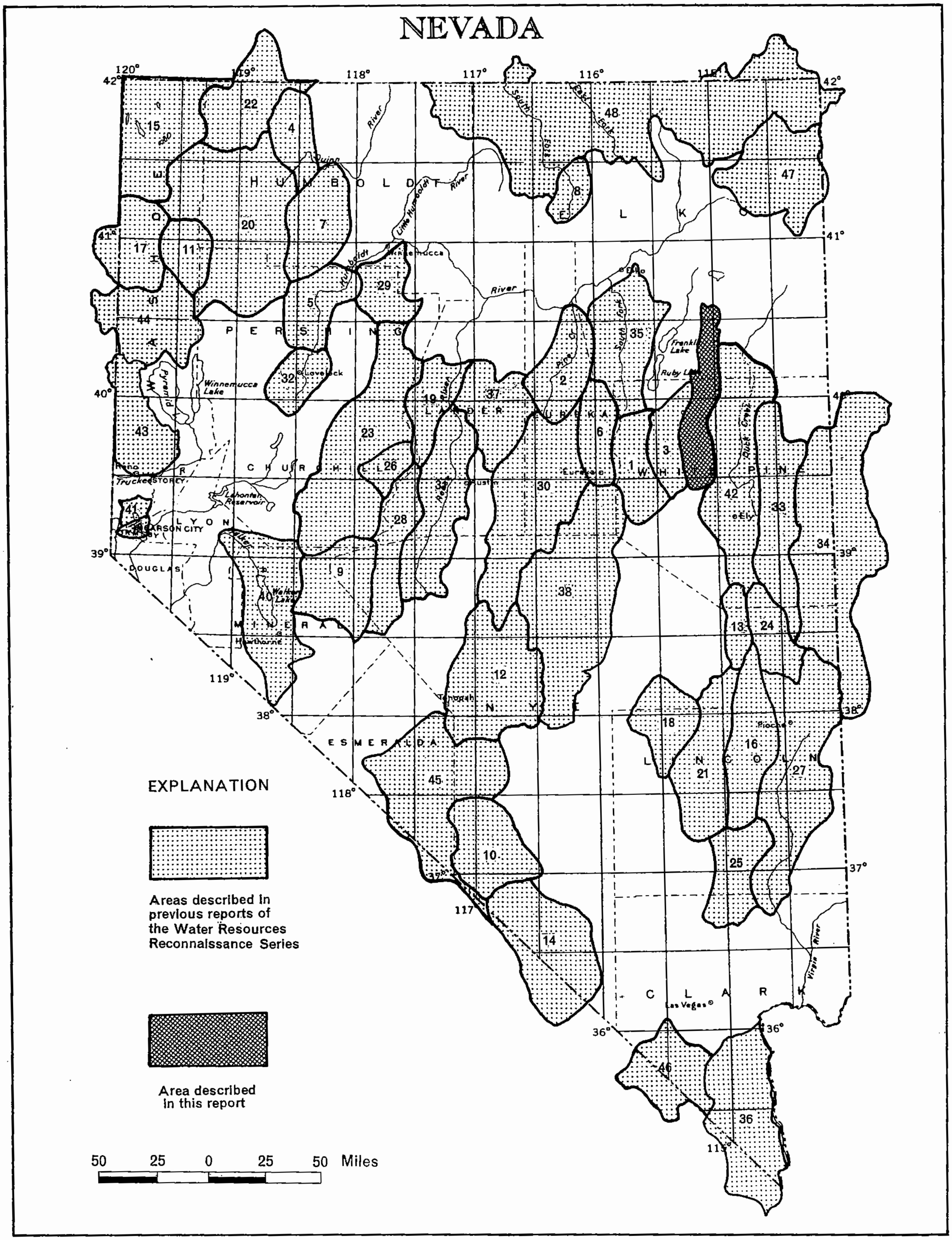

Figure 1.—Areas in Nevada described in previous reports of the Water Resources Reconnaissance Series and the area described in this report

Butte Valley is very sparsely populated; altogether, the total permanent residents probably number less than 30. Southern Butte Valley contains two ranches, the Uhalde Ranch in the southwestern part and Paris Ranch in the northern part. The Robert Healy Ranch, in the southwestern part of northern Butte Valley, on the Odgers Ranch Indian Reservation (pl. 1), currently houses the only permanent residents of that valley.

Ranching is the sole occupation of the area's residents and historically has been the main occupation. In 1967, the Bear Creek Mining Corporation reportedly was conducting exploration in and near T. 22 N., R. 61 E., in southern Butte Valley, and although their findings may influence the future economy of the area, no permanent residents are presently involved. In addition, some oil exploration has been done in the area.

The nearest towns are to the east and southeast in adjacent Steptoe Valley and include the small settlements of Currie and Cherry Creek, and the towns of Ely and McGill. The small town of Currie is about 8 miles east of northern Butte Valley.

Early Development

The earliest use of water resources by white men in Butte Valley was by explorers in the mid-1800's. Springs around the edges of the valley probably were used by Major George Chorpenning's overland mail carriers. Chorpenning was a trailmaker and Indian fighter and also the contractor in charge of the first overland mail service during the early 1850's (Chapman, 1932, p. 41). Much of the route his mail service followed was originally traveled by Major Howard Egan, a scout and captain under Brigham Young. The route and some of the watering places established in the Butte Valley area by Chorpenning's ventures were in general also utilized by Capt. J. H. Simpson of the Corps of Topographical Engineers during his exploration of the Great Basin. Capt. Simpson, also employing Major Howard Egan as a guide, had as his objective the search for a direct wagon route between Camp Floyd, Utah, and the new settlement at Genoa in Carson Valley of western Nevada. He traveled up Egan Canyon, over the Cherry Creek Mountains, and across Butte Valley on May 15, 1859 (Simpson, 1876, p. 60-62).

The famous Pony Express of 1860-61 utilized Simpson's route through this part of the State and was also dependent for its water supply on the springs discharging from the consolidated rocks bordering the valley. In the period between the termination of the Pony Express and the influx of permanent settlers, the valley was intermittently used as a haven for horse thieves and their stolen livestock (Mr. B. Paris, oral commun., 1967).

GENERAL HYDROLOGIC ENVIRONMENT

Physiographic Features

The report area is a small topographically closed segment of the Great Basin. It consists of an elongate structural depression nearly surrounded by mountains. The valley actually comprises two separate drainage basins, previously referred to as northern and southern Butte Valleys. They are separated by a narrow alluvial divide of very gentle relief compared to that generally separating Butte Valley from adjacent valleys.

Altitudes in northern Butte Valley range from about 5,990 feet on the playa to 9,498 feet at Mt. Taylor in the Cherry Creek Mountains, and therefore, the maximum relief is about 3,500 feet. The altitudes of southern Butte Valley range from about 6,160 feet on the valley floor to 10,600 feet in the Cherry Creek Mountains, and the maximum relief is about 4,400 feet. The Cherry Creek Mountains, forming much of the eastern boundary of the area, are also the highest range in the area. Maximum altitude of the Butte Mountains is about 9,030 feet and that of Medicine Range is about the same. The highest part of Spruce Mountain within the area has an altitude of about 10,080 feet. West Buttes, Palomino Ridge, Valley Mountain, and Delcer Buttes have maximum altitudes of 7,654, 7,383, about 7,200, and 6,908 feet, respectively.

Observation of the terrane discloses the following topographic characteristics: (1) relatively flat valley floors; (2) a system of smoothly coalescing alluvial fans joining the bases of the mountain ranges with the alluvial valley floors; (3) the alluvial fans are generally typified by surfaces that appear smooth and undissected compared to many alluvial fans in the basin and range physiographic province; and (4) generally rugged mountain masses that commonly rise abruptly and steeply above the heads of the alluvial fans.

According to relic shorelines visible on aerial photos, the maximum stillstand altitudes of Pleistocene lakes were as follows: northern Butte Valley, about 6,050 feet; southern Butte Valley, about 6,300 feet. The lake in southern Butte Valley may have spilled northward through the narrow alluvial gap into northern Butte Valley during its highest stand, and that in northern Butte Valley probably spilled to or was connected with the lake in Ruby Valley to the west.

Table 2.--Generalized geologic units

	Geologic age		Geologic unit	Thickness (feet)	General character and extent	Water-bearing properties
QUATERNARY	Holocene and Pleistocene	VALLEY FILL	Younger alluvium	0-100±	Unconsolidated lenses of gravel, sand, silt, and clay comprising fluvial, lacustrine, and eolian deposits; fluvial deposits commonly contain large-size gravel and boulders; lacustrine deposits range from clay-size particles to sand and gravel bar deposits; eolian deposits mainly silt-size material with some sand; detritus composed mainly of material derived from bordering upland consolidated rocks and reworking of older alluvium; unit probably thickest in valley troughs; probably mantles older alluvium over much of its extent	Yields water to domestic and stock wells where saturated; yields are variable, depending on character of deposits encountered by wells, and range from about 5 gpm to possibly several hundred gpm The younger and older alluvium together form the valley-fill reservoir, the principal source of water for wells in the area
TERTIARY(?) AND QUATERNARY	Pleistocene and older(?)	VALLEY FILL	Older alluvium	0-several thousand(?)	Unconsolidated to semiconsolidated deposits of boulders, gravel, sand, silt, and clay exposed around margins of valley and buried at generally shallow depth beneath younger alluvium; composed mainly of debris derived from bordering consolidated rock areas; detrital constituents may be somewhat altered from their original character at time of deposition; alteration of unit may include decrease in transmissivity caused by cementation; unit thinnest in upland areas and thickest beneath valley troughs; mantles consolidated rock; probably present nearly everywhere beneath younger alluvium	May yield water to some stock wells; yields probably vary depending on character of deposits and may be several hundred gpm or more
CAMBRIAN TO TRIASSIC	Triassic to Middle Cambrian	CONSOLIDATED ROCKS[1]	Carbonate rocks[2]	0-several thousand	Mainly limestone and dolomite; unit may contain minor strata of noncarbonate rocks; structurally deformed; general extent shown on plate 1; unit probably occurs extensively beneath valley-fill deposits	Transmits water through fracture and solution cavities; interbasin subsurface flow may occur through these conduits; unit untested by wells; yields water to springs and perennial streams
PRECAMBRIAN TO TERTIARY	Tertiary to late Pre-Cambrian	CONSOLIDATED ROCKS[1]	Non-carbonate rocks[2]	—	Igneous, metamorphic, and sedimentary rocks; igneous rocks are mainly volcanics including basalt and ignimbrite; some small intrusives also present, mainly in northern Butte Valley; metamorphic rocks are mainly argillite and quartzite; sedimentary rocks include sandstone, siltstone, and shale; all rock types have been structurally deformed; general extent of unit shown on plate 1	Unit generally untested by wells; yields minor amounts of water to springs; might yield small amounts of water to wells locally from fracture zones; considered poorest water-yielding unit in area

1. Carbonate and noncarbonate rocks may be interbedded and are not discrete geologic time units.
2. Synthesized from various reports, as credited on plate 1.

VALLEY-FILL RESERVOIR

Extent and Boundaries

The valley-fill reservoir is formed by the older and younger alluvium, which extends continuously from the south end to the north end of Butte Valley, as shown on plate 1. However, the topographic divide between the northern and southern parts of Butte Valley also nearly coincides with the ground-water divide. Therefore, the valley-fill reservoir in northern Butte Valley is considered contiguous to but separate from the reservoir in southern Butte Valley. The ground-water divide, which could become transient if substantial ground-water development occurred, forms the hydraulic divide between the two areas.

The sides of the valley-fill reservoir are formed by the consolidated rocks, where they are present. The western side of northern Butte Valley locally is valley fill, which extends continuously into Ruby Valley. The alluvium at the north end of the valley extends continuously beneath the topographic divide into Clover Valley, but the divide area probably is underlain at shallow depth by consolidated rocks.

Occurrence and Movement of Ground Water

The known depth below land surface to the zone of saturation in the valley-fill reservoir ranges from about land surface in spring areas to about 150 feet in well 20/61-6dl. Throughout most of the area, shallow depths to water exist near the valley floors and generally increase toward the mountains. Exceptions to this generality occur in the northern part of southern Butte Valley and the southern part of northern Butte Valley where springs discharge from the alluvium at altitudes above the valley floor. This occurrence and the north-trending alinement of the springs strongly suggest structural control of the spring orifices. Westward ground-water flow toward the valley floor is being impeded by decreased permeability, causing the spring discharge. The movement in northern Butte Valley is generally toward the playa in the northwestern part of the valley. Water-level altitudes indicate that subsurface flow continues westward to Ruby Valley beneath the alluvial divide. (See section, "Subsurface outflow to adjacent valleys.")

In southern Butte Valley, ground water in the valley-fill reservoir moves toward the playa in the southern part of the valley where the depth to water is at least 50 feet (water-level altitude about 6,100 feet). Whether the sparse phreatophytes in the playa area consume sufficient ground water to keep the water level depressed to this depth is not known. The possibility of leakage into the underlying carbonate rocks and outflow to adjacent valleys is discussed in the section, "Subsurface outflow to adjacent valleys."

INFLOW TO THE VALLEY-FILL RESERVOIR

Precipitation

The general climate of east-central Nevada is arid to semiarid. The valley floors are arid and most precipitation falls on the surrounding mountains. The higher peaks are occasionally wet enough to be considered subhumid. Although no weather-recording stations are in Butte Valley, several are in nearby areas (fig. 2).

Precipitation is the source of virtually all water entering the hydrologic system of the report area. Throughout the area annual precipitation probably ranges from about 6 inches on the valley floor to more than 20 inches on the tops of higher mountains. This assumption is based on selected recorded data for adjacent areas (table 3), the area's topographic characteristics, and a precipitation map of Nevada (Hardman, 1965). Some precipitation occurs as rain, but much of it falls as snow during the winter and early spring, particularly at higher altitudes. Most regional precipitation occurs during late autumn, winter, and spring, as shown by data in table 4. Regional precipitation is generally lowest and least expected during the summer. However, high intensity local thundershowers occur unpredictably during the summer.

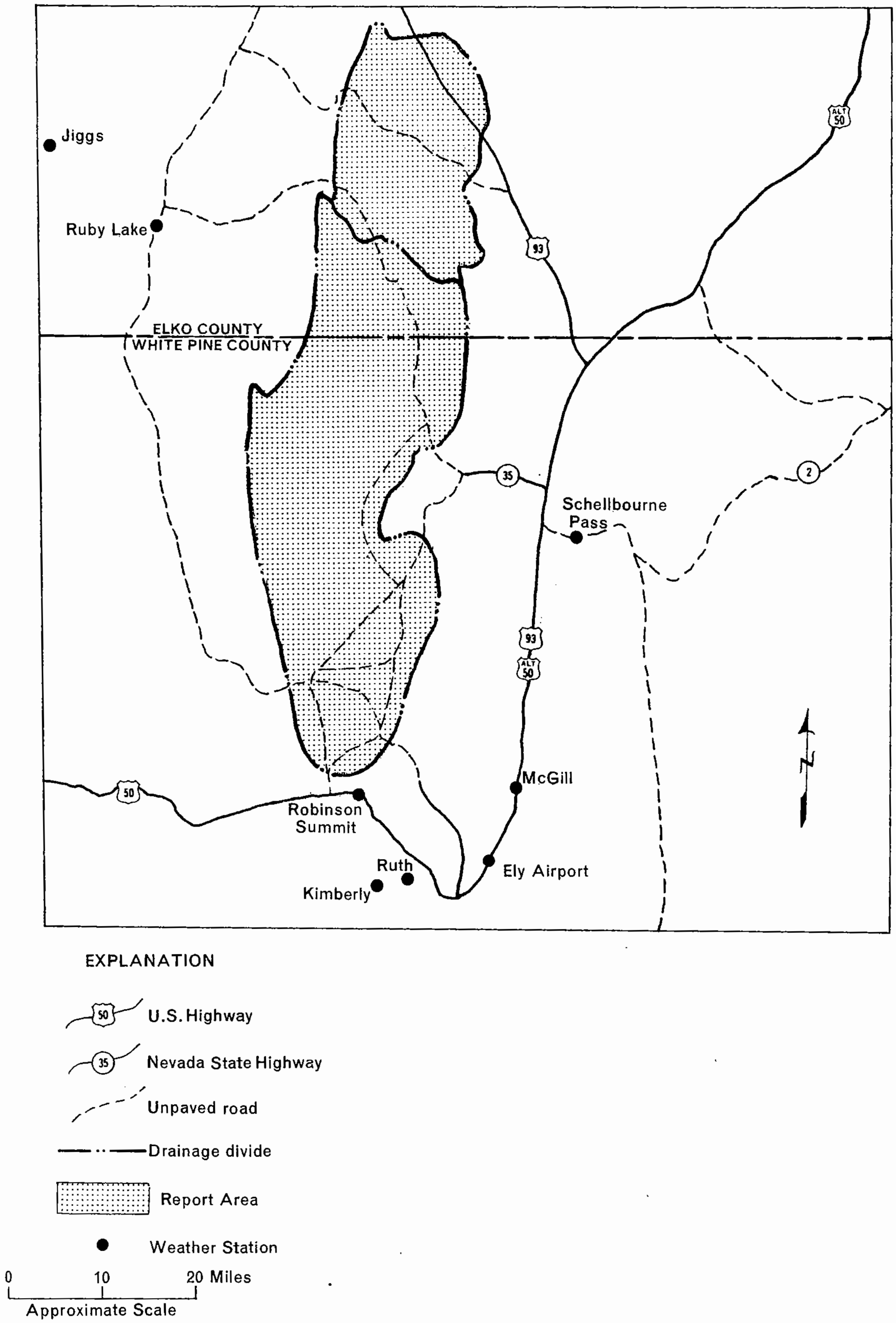

Figure 2.— Location of roads and weather stations.

Table 3.--Summary of average annual precipitation at selected stations

[Summarized from published records of the U.S. Weather Bureau]

Station	Location[1]	Altitude (feet)	Period of record (years)	Average annual precipitation (inches)	Remarks
Ely Airport	17/63-35	6,257	28 years; 1939-66	8.34	
Jiggs	30/56-34	5,450	55 years; 1910-42, 1945-66	12.10	
Kimberly	16/62-8	7,250	29 years; 1929-57	13.24	
McGill	18/64-28	6,340	54 years; 1913-66	8.93	
Robinson Summit	18/61-23	7,630	13 years; Oct. 1953-Sept. 1966	9.94	Storage gage
Ruby Lake	27/58-19	6,012	24 years; 1940-43, 1945-50, 1952-55, 1957-66	12.49	
Ruth	16/62-3or4	6,832	8 years; 1959-66	10.76	
Schellbourne Pass	22/65-8	8,150	10 years; 1955-64	11.20	Storage gage

1. Station locations shown in figure 2.

Surface Water

By. D. O. Moore

General Conditions

Northern and southern Butte Valleys are topographically closed basins and have no well-defined axial stream channels on their valley floors. Most of the runoff derived in the mountain blocks drain to the valley floors in ephemeral channels. Only five significant perennial streams occur in the area: Snow, Taylor Canyon, and Paris Creeks on the west flank of the Cherry Creek Range, and two small unnamed creeks, one each in northern and southern Butte Valleys, are springfed during low-flow periods. The unnamed creek of northern Butte Valley collects springflow in the western part of T. 27 N., R. 62 E., and that of southern Butte Valley in the southwestern part of T. 19 N., R. 62 E., also probably flows perennially from springflow.

In addition to streamflow from the mountain blocks, occasional flow may occur locally on the alluvial fans and lowlands in response to heavy precipitation from thunderstorms. Generally, this type of streamflow is so erratic in frequency and duration that it has little value to economic development.

No records of streamflow have been obtained on the streams in Butte Valley. For the purpose of this study, miscellaneous discharge measurements were made on Snow, Taylor Canyon, and Paris Creeks. Estimates of flow were also made for the two unnamed creeks. The data obtained are shown in table 5.

Streamflow in Butte Valley is variable with respect to the time of the year and from year to year. As there is no record of gaged streamflow in the area, records of a nearby gaged stream were used to show the variability of streamflow. This stream, Overland Creek near Ruby Valley (not shown on pl. 1), which is to the northwest of Butte Valley, is assumed to have the same general flow characteristics as the streamflow in Butte Valley. The graph in figure 3 shows the annual streamflow pattern for Overland Creek at the gaging station. The monthly plot points are shown as a percentage of the average annual streamflow. The middle lines of the graphs represent the median distribution of the monthly mean discharge for each month; that is, for each month, 50 percent of the monthly flows of record were less than and 50 percent were more than

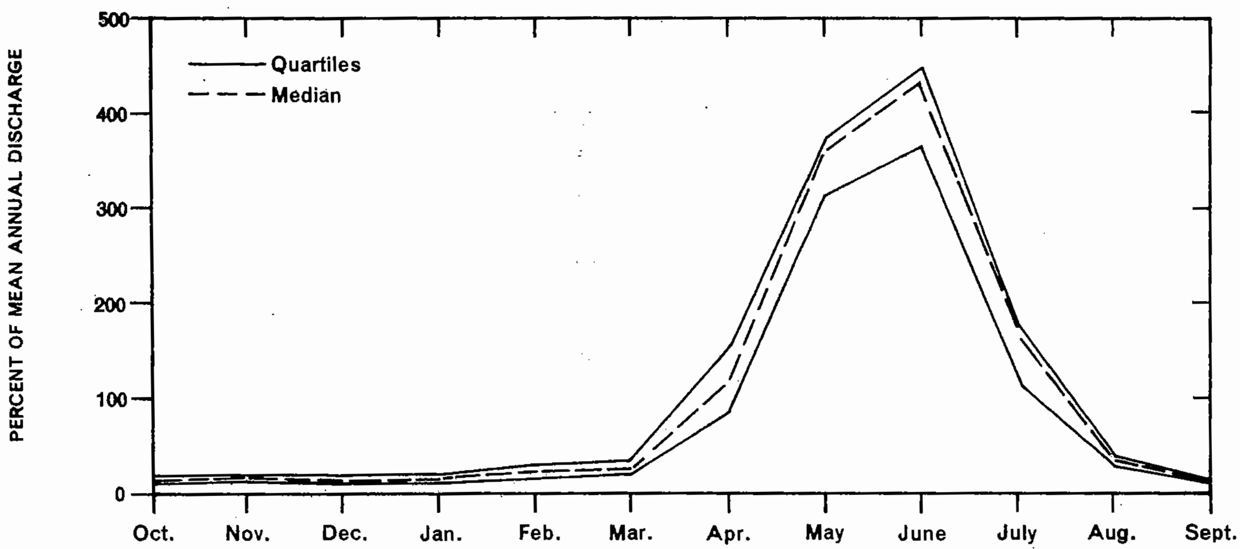

Figure 3.—Monthly discharge in percent of mean annual discharge of Overland Creek near Ruby Valley, Nevada (1960-65).

the proportional amount shown by the graph. The upper line of the graph, the upper quartile, represents a plot of the proportional monthly flow for which only 25 percent of the monthly flows of record were higher than and 75 percent were less than the proportions indicated. The lower line of the graph, the lower quartile represents a plot of the monthly proportion of annual flow for which 75 percent of the monthly flows of record were greater than and 25 percent were less than the proportion indicated. It can be noted from figure 3 that the annual hydrograph of flow for Overland Creek reflects a dominant influence of snowmelt runoff. This is also assumed true for streams in Butte Valley.

Estimated Average Annual Runoff

The amount of runoff that reaches the alluvial fans from the mountain blocks cannot be computed directly because of a scarcity of available streamflow data. Methods have been devised recently to estimate runoff in Nevada, particularly for application to areas where few or no streamflow records are available. These methods were described in detail by Moore (1968). Using the drainage areas supplying the natural flow to streams where gaging stations had been or are operated, recorded runoff is prorated by altitude zones (1,000-foot intervals) with due regard to the proportional areas of the several zones and with increasing unit values of runoff for increasing altitudes. As the different physical characteristics such as vegetation, geology, types of soil, and amounts of precipitation vary locally within large areas, the runoff for each altitude increment is adjusted accordingly. The adjustment of the runoff coefficients for local conditions are based on measurements of streamflow and channel geometry.

The estimated average annual runoff in Butte Valley, summarized in table 6, totals about 12,000 acre-feet per year. The runoff is not evenly distributed throughout the valley. It is estimated that about 80 percent occurs in the mountains on the eastern side and the remainder on the western side. On the eastern side, that part of the Cherry Creek Range north of the road between Cherry Creek and Butte Valley, though comprising less than 30 percent of the total runoff area, yields about 50 percent of the total runoff.

Ground-Water Recharge

Ground-water recharge in the Butte Valley area is derived mainly from precipitation within the area. A method described by Eakin and others (1951, p. 79-81) is used to estimate recharge in this report. The method assumes that a percentage of the average annual precipitation recharges the ground-water reservoir. Hardman (1965) showed that in gross aspect the average annual precipitation in Nevada is related closely to altitude and that it can be estimated with a reasonable degree of accuracy by assigning precipitation rates to various altitude zones. Estimates of recharge are shown in table 7. The estimated average annual precipitation on Butte Valley is about 560,000 acre-feet, and the estimated average annual recharge is about 19,000 acre-feet. Thus, about 3.4 percent of the total precipitation is computed to reach the ground-water reservoir.

Much of the recharge probably occurs by seepage loss as the streams cross the alluvial fans; however, the estimated mean annual runoff at the valley fill-consolidated rock contact of 12,000 acre-feet is considerably less than the estimated average annual recharge of 19,000 acre-feet. Much of the recharge reaching the valley floor may occur in the mountains by infiltration of precipitation and runoff into the carbonate rocks. The highly transmissive and structurally deformed character of the carbonate rocks can strongly affect the magnitude and direction of ground-water flow through these rocks. Therefore, the recharge boundaries, arbitrarily chosen to be coincident to surficial drainage boundaries for the compilation of table 7, may not be correct. However, because of the reconnaissance nature of the study and the lack of conclusive data that would permit a more accurate determination of recharge boundary locations, the surficial drainage boundaries were utilized for computation purposes. Some of the recharge in the mountains of southern Butte Valley may actually be moving as underflow through the carbonate rocks to northern Butte Valley or to adjacent valleys.

OUTFLOW FROM THE VALLEY-FILL RESERVOIR

Irrigation Use

Farming in the valley is mainly restricted to a small amount of irrigation of alfalfa and native pasture. Growing-season length is one of the main factors that has influenced agricultural development of the valley. Temperature data, useful in determining and predicting the growing season length, are unavailable for Butte Valley proper.

Temperature data are recorded at a few nearby stations outside the report area, as shown in figure 2. Since 1949, the U.S. Weather Bureau has published freeze data for many of their temperature-recording stations; these data for five stations in adjacent areas are summarized in table 8. Because killing frosts vary with the type of crop, temperatures of 32°F, 28°F, and 24°F are used to determine the number of days between the last spring minimum (prior to July 1) and the first fall minimum (after July 1). The temperature stations at Ely Airport and Ruby Lake are on or near the floors of their respective valleys, and their altitudes are similar to those of the actual and potential agricultural areas of Butte Valley. However, their respective growing seasons are somewhat dissimilar (table 8). The length of growing season on the floor of Butte Valley may be between those of the Ely Airport and Ruby Lake temperature stations. Thus, the growing season for crops experiencing a killing frost of 28°F would probably average between 104 and 130 days, based on data collected between 1950 and 1966 (table 8). In any event, a somewhat shorter growing season would be expected on the valley floor than on the alluvial slopes because of the tendency for cooler air to accumulate at lower altitudes in most closed or partially closed Nevada valleys.

Irrigation of alfalfa and native pasture has been limited in part to diversion of perennial streams and springs and in part by natural subirrigation in areas of shallow ground water. The springfed streams and the shallow depth of ground water in irrigated areas complicates a clear-cut separation of surface-water and ground-water sources. Nevertheless, rough estimates have been made as to source of supply. Table 9 shows the estimated consumptive use of stream, spring, and shallow ground water in the valley.

Evapotranspiration

Evapotranspiration from the valley-fill reservoir is greatest in the northern half of southern Butte Valley and in the southern half of northern Butte Valley (pl. 1). These areas are not at the lowest altitudes of their respective valley segments; rather, they

Table 9.--Estimated consumption of water by irrigated and subirrigated crops

Ranch	Crop	Approximate area irrigated (acres)	Estimated rate (feet per year)	Estimated consumptive use (acre-feet per year): Diversion of streams and springs	Shallow ground water[1]	Total
		NORTHERN BUTTE VALLEY				
Healy Ranch	Alfalfa	100	a 2	b 200	--	200
Do.	Do.	60	a 2	120	--	120
Do.	Native pasture	640	1	b 320	320	640
Ranch (owner unknown)	Do.	140	1	b 70	70	140
Total		940		710	390	1,100
		SOUTHERN BUTTE VALLEY				
Paris Ranch	Alfalfa	150	a 2	300	--	300
	Crested wheat grass	30	1	30	--	30
Stratton Ranch	Alfalfa	60	a 2	b 60	c 60	120
	Native pasture	780	1	b 50	c 730	780
Total		1,020		440	790	1,200

1. Depth to water generally less than 5 feet.

a. Alfalfa use estimated at 1 foot per cutting; alfalfa reportedly yields two cuttings per year.

b. Supply mostly from springs.

c. Supplemented by diversion of Snow Creek when it is flowing.

Table 10.--Estimated average annual evapotranspiration of ground water in nonirrigated areas

Phreatophyte or type of discharge	Approximate area (acres)	Depth to water range (feet)	Estimated water use rate (feet per year)	Estimated ground-water discharge (acre-feet per year)
		NORTHERN BUTTE VALLEY		
Evaporation from ponds, reservoirs, and streams	10	--	3.5	35
Mostly meadow grass	1,400	2-5	0.75	1,000
Do.	4,000	0-10	0.5	2,000
Rabbitbrush and greasewood	13,000	10-35	0.2	2,600
Greasewood	13,000	30-50+	0.1	1,300
Total (rounded)	31,400			6,900
		SOUTHERN BUTTE VALLEY		
Evaporation from ponds, reservoirs, and streams	10	--	3.5	35
Saltgrass	9,400	0-10	0.5	4,700
Rabbitbrush and greasewood	22,000	10-35	0.2	4,400
Greasewood	14,000	30-50+	0.1	1,400
Total (rounded)	45,400			11,000

Subsurface Outflow to Adjacent Valleys

Ground water moving northward in northern Butte Valley is consumed principally by evapotranspiration; the residual flows westward to Ruby Valley mainly through older alluvium. Some outflow may also occur through the underlying carbonate rocks. Underflow can be computed by means of a form of Darcy's law

$$Q = 0.00112\ TIW$$

in which *Q* is the quantity of flow, in acre-feet per year; *T* is the coefficient of transmissibility, in gallons per day per foot; *I* is the hydraulic gradient, in feet per mile; *W* is the effective width of the underflow section, in miles; and 0.00112 is a factor for converting gallons per day to acre-feet per year.

The effective width along the alluvial divide between northern Butte Valley and Ruby Valley probably is about 2 miles. The coefficient of transmissibility of the older alluvium is assumed to be 50,000 gallons per day per foot. The hydraulic gradient, based on wells 30/62-18c1 and 30/61-7d1 (water-level altitudes 5,935 and 5,895 feet, respectively), is 40 feet in 5.5 miles, or about 7 feet per mile. The estimated outflow, using the above equation and foregoing values, is computed to be about 800 acre-feet per year.

Pumpage

All wells drilled in the report area are used for domestic or stockwatering purposes. Only about 16 wells were known to be in use in 1967; these are listed in table 15. In northern Butte Valley, 200 head of cattle each using about 15 gpd (gallons of water per day) would consume about 3 acre-feet per year; 5 people, using about 100 gpd, would consume about 0.5 acre-foot per year; total domestic and stock consumption in that valley probably is less than 10 acre-feet per year. In southern Butte Valley, 7,000 sheep each using about 2 gpd would consume about 15 acre-feet per year; 500 cattle, about 7 acre-feet; and 25 people, about 2.5 acre-feet; total domestic and stock consumption in that valley probably is about 25 acre-feet per year. Therefore, total domestic and stock consumption in Butte Valley probably is less than 35 acre-feet per year.

Table 12.--Preliminary ground-water budget for near-natural conditions

(All estimates in acre-feet per year)

Budget elements	Northern Butte Valley (1)	Southern Butte Valley (2)	Butte Valley total (1)+(2)
RECHARGE:			
From precipitation (table 7)	3,900	15,000	19,000
Subsurface inflow	--	--	--
Total (rounded): (1)	3,900	15,000	19,000
DISCHARGE:			
Irrigation use (table 9)[1]	980	900	1,900
Evapotranspiration (table 10)[2]	6,900	11,000	18,000
Subsurface outflow (p. 30)	800	--	800+
Pumpage (p. 30)	10	25	35
Total (rounded): (2)	8,700	12,000	21,000
IMBALANCE: (1) - (2)	-4,800	3,000	2,000
RECONNAISSANCE VALUE SELECTED FOR RECHARGE AND DISCHARGE	6,300	14,000	20,000

1. Includes estimated ground-water discharge only from springs and shallow water table; excludes stream diversions.

2. Evapotranspiration in nonirrigated areas includes discharge from springs and shallow water table.

Table 13.--Partial chemical analyses of water from wells, springs, and streams

[Field-office analyses by the U.S. Geological Survey]

Location	Date sampled	Temperature °F	Temperature °C	Milligrams per liter (upper number) and milliequivalents per liter (lower number)[1/]: Calcium (Ca)	Magnesium (Mg)	Sodium (Na) plus potassium (K)[3/]	Bicarbonate (HCO_3)[4/]	Sulfate (SO_4)	Chloride (Cl)	Hardness as $CaCO_3$	Specific conductance (micromhos per cm at 25°C)	pH (lab. determination)	Factors affecting suitability for irrigation[2/]: Salinity hazard	Sodium adsorption ratio (SAR)	Sodium hazard	Residual sodium carbonate (RSC)
WELLS																
21/61-6c1	9-22-65	—	—	45 2.25	28 2.33	53 2.29	122 2.00	47 0.98	138 3.89	229 4.58	629	8.0	Medium	1.5	Low	S(0.00)
22/61-6c1	10- 5-65	48	9	28 1.40	18 1.46	15 0.64	154 2.52	32 0.67	11 0.31	143 2.86	298	8.2	Medium	.5	Low	S(0.00)
23/61-7d1	9-22-65	47	8	25 1.25	20 1.63	37 1.60	201 3.29	28 0.58	11 0.31	144 2.88	373	8.4	Medium	1.3	Low	S(.71)
24/61-14c1	9-22-65	56	13	37 1.85	29 2.35	32 1.38	159 2.61	64 1.33	58 1.64	210 4.20	534	8.1	Medium	1.0	Low	S(0.00)
25/62-17b1	8-16-67	54	12	51 2.54	18 1.52	12 0.51	240 3.93	20 0.42	7.9 0.22	203 4.06	410	8.0	Medium	.4	Low	S(0.00)
26/62-22a1	8-13-67	—	—	44 2.20	18 1.48	8.0 0.35	222 3.64	9.6 0.20	4.2 0.12	184 3.68	350	8.3	Medium	.3	Low	S(.03)
SPRINGS																
20/60-33d1	8-15-67	48	9	26 1.30	5.1 0.42	16 0.68	124 2.03	8.7 0.18	6.9 0.19	86 1.72	230	7.7	Low	.7	Low	S(.31)
22/62-21d1	8-21-67	51	10	58 2.89	6.4 0.53	22 0.97	210 3.44	24 0.50	16 0.45	171 3.42	420	7.6	Medium	.7	Low	S(.02)
26/22-15c1	8-18-67	57	14	40 2.00	19 1.56	7.4 0.32	208 3.41	14 0.29	6.5 0.18	178 3.56	350	8.0	Medium	.2	Low	S(0.00)
26/62-33d1	8-18-67	50	10	42 2.10	19 1.54	9.0 0.39	220 3.61	12 0.25	6.2 0.17	182 3.64	350	8.0	Medium	.3	Low	S(0.00)
a 27/62-33c1	8-19-67	—	—	44 2.20	21 1.72	3.0 0.13	222 3.64	13 0.27	4.9 0.14	196 3.92	360	8.2	Medium	.1	Low	S(0.00)
a 28/61-2d1	8-19-67	58	14	42 2.10	17 1.36	10 0.44	199 3.26	21 0.44	7.2 0.20	173 3.46	350	7.9	Medium	.3	Low	S(0.00)
a 28/61-11d1	8-19-67	—	—	37 1.85	16 1.29	11 0.48	183 3.00	19 0.40	7.9 0.22	157 3.14	330	8.0	Medium	.4	Low	S(0.00)
a 28/61-26d1	8-19-67	56	13	39 1.95	19 1.59	11 0.48	195 3.20	26 0.54	10 0.28	177 3.54	360	8.1	Medium	.4	Low	S(0.00)
a 28/62-9c1	8-20-67	—	—	63 3.14	27 2.23	21 0.93	332 5.44	30 0.62	8.6 0.24	269 5.37	590	7.8	Medium	.6	Low	S(.07)
a 29/62-23d1	8-19-67	67	19	62 3.09	28 2.30	21 0.90	288 4.72	62 1.29	10 0.28	270 5.39	540	8.0	Medium	.5	Low	S(0.00)
STREAMS																
Unnamed creek 19/62-30b1	8-15-67	65	18	39 1.95	7.9 0.65	24 1.06	178 2.92	19 0.40	12 0.34	130 2.60	340	7.9	Medium	.9	Low	S(.32)
Paris Creek 25/62-21	10- 5-65	50	10	21 1.05	23 1.89	12 0.53	158 2.59	24 0.50	5.4 0.15	147 2.94	269	8.4	Medium	.4	Low	S(0.00)
Snow Creek 26/62-35	10- 5-65	51	10	27 1.35	10 0.85	8.7 0.38	126 2.07	18 0.37	4.8 0.14	110 2.20	200	8.1	Low	.4	Low	S(0.00)
Unnamed creek a 27/62-8c1	8-19-67	70	21	24 1.20	20 1.62	8.5 0.37	171 2.80	13 0.27	4.2 0.12	141 2.82	290	8.2	Medium	.3	Low	S(0.00)
Taylor Creek a 27/62-12	10- 5-65	54	12	25 1.25	15 1.25	13 0.58	146 2.39	24 0.50	6.8 0.19	125 2.50	238	8.2	Low	.5	Low	S(0.00)

1. Milligrams per liter and milliequivalents per liter are metric units of measure that are virtually identical to parts per million and equivalents per million, respectively, for all waters having a specific conductance less than about 10,000 micromhos. The metric system of measurement is receiving increased use throughout the United States because of its value as an international form of scientific communication. Therefore, the U.S. Geological Survey recently has adopted the system for reporting all water-quality data.

2. Salinity hazard is based on specific conductance (in micromhos) as follows: low, 0-250; medium, 251-750; high, 751-2,250; very high, >2,250. Sodium-adsorption ratio (SAR) provides an indication of what effect an irrigation water will have on soil-drainage characteristics. SAR is calculated as follows, using milliequivalents per liter: $SAR = Na/\sqrt{(Ca + Mg)/2}$. Sodium hazard is based on an empirical relation between salinity hazard and sodium-adsorption ratio. Residual sodium carbonate (expressed in milliequivalents per liter) is tentatively related to suitability for irrigation as follows: safe (S), 0-1.25; marginal (M), 1.26-2.50; unsuitable (U), >2.50. The several factors should be used as general indicators only, because the suitability of a water for irrigation also depends on climate, type of soil, drainage characteristics, plant type, and amount of water applied. These and other aspects of water quality for irrigation are discussed by the U.S. Salinity Laboratory Staff (1954).

3. Computed as the milliequivalent-per-liter difference between the determined negative and positive ions; expressed as sodium. Computation assumes that concentrations of undetermined ions--especially nitrate--are small.

4. All carbonate (CO_3) values 0 mg/l except: 23/61-7d1, 9 mg/l (0.30 meq/l); 26/62-22a1, 2 mg/l (0.07 meq/l); 25/62-21, 7 mg/l (0.23 meq/l).

a. In northern Butte Valley. If not footnoted, in southern Butte Valley.

Suitability of Water for Various Uses

Factors affecting the suitability of Butte Valley waters for agriculture are shown in table 13. The factors are based on consideration of several of the chemical characteristics that were determined for the sampled waters. The presence of boron, which was not determined in the analyses, is also an important factor that determines suitability of water for agriculture. Boron, which is necessary in small quantities for healthy plant growth, is toxic to plants when present in water in quantities only slightly exceeding the desirable amount.

Increased agricultural development in the study area may ultimately be influenced as much by the chemical quality as by the quantity of available water. Evaluation of prospective agricultural development warrants careful consideration of the chemical quality of the water and the chemical and physical character of the lowland soils. This would help ensure compatibility of soil and irrigation water with the type of crops planned.

Future recycling of ground water for intensive irrigation around the lowland areas probably would degrade the chemical quality of the water, particularly if commercial fertilizers are used in substantial quantities and if the soils contain appreciable quantities of leachable salts.

Drinking-water standards recommended by the U.S. Public Health Service (1962) commonly are cited as limits for domestic use. Several of these standards are as follows:

Chemical constituent	Recommended maximum concentration (mg/l)
Sulfate	250
Chloride	250
Total dissolved solids	500

As indicated by table 13 and the above tabulation, all waters analyzed are acceptable for human consumption, based on their sulfate, chloride, and total dissolved-solids content.

Hardness of water, which is mainly caused by calcium and magnesium, adversely affects suitability of water for domestic use, especially for cooking and washing, and may also be detrimental to certain industrial uses. The U.S. Geological Survey uses the following classification of water hardness:

THE AVAILABLE WATER SUPPLY

The available ground-water supplies of the two valleys of the area consists of two interrelated entities: (1) perennial yield, and (2) transitional storage reserve, which are described below.

Perennial Yield

Perennial yield of a ground-water reservoir may be defined as the maximum amount of water of usable chemical quality that can be withdrawn and consumed economically each year for an indefinite period of time. If the perennial yield is continually exceeded, water levels will decline until the ground-water reservoir is depleted of water of usable quality or until the pumping lifts become uneconomical to maintain. Perennial yield cannot exceed the natural recharge to an area and ultimately is limited to the maximum amount of natural discharge that can be salvaged for beneficial use. Salvage of natural discharge implies diversion of ground water presently destined for areas of natural discharge to areas of pumping. A method of accomplishing the diversion is the lowering of water levels in and near areas of natural discharge by scheduled depletion of storage according to the concept of transitional storage reserve (defined below).

Table 12 shows that the reconnaissance values selected for recharge and discharge for northern and southern Butte Valleys are 6,300 and 14,000 acre-feet per year, respectively. In northern Butte Valley, where about 980 acre-feet per year has been salvaged for irrigation use, most of the selected natural discharge probably could be salvaged for useful purposes. Thus, the estimated perennial yield is about 6,000 acre-feet.

In southern Butte Valley, where about 900 acre-feet per year has been salvaged for irrigation use, most of the selected natural discharge probably also could be salvaged for beneficial use. Therefore, the estimated perennial yield is about 14,000 acre-feet. The perennial yield for Butte Valley as a whole, then, is about 20,000 acre-feet.

When considering the location of wells or other development to salvage the natural discharge for beneficial use, table 14 shows the distribution and approximate percentage of natural evapotranspiration in the two valleys. The table does not include the 1967 irrigation use.

Transitional Storage Reserve

Transitional storage reserve has been defined by Worts (1967) as the quantity of water in storage in a particular ground-water reservoir that can be extracted and beneficially used during the transition period between equilibrium conditions in a state of nature and new equilibrium conditions under the perennial yield concept of ground-water development. In the arid environment of the Great Basin, the transitional storage reserve of such a reservoir is the amount of stored water available for withdrawal by pumping during the nonequilibrium period of development or period of lowering water levels. Therefore, transitional storage reserve is a specific part of the water available from ground water in storage; it is a quantity additional to that of perennial yield, but can be withdrawn on a once-only basis.

Ground-water development inherently involves storage depletion; the magnitude of depletion is commensurate with the amount of pumpage, the hydraulic characteristics of the aquifer, and locations of wells with respect to recharge and discharge boundaries. Desert valleys often have well-defined discharge boundaries, such as areas of evapotranspiration, but recharge boundaries, such as live streams or lakes, are uncommon.

Computation of transitional storage reserve for valleys of the report area was based on the following assumptions: (1) Development wells would be strategically located in, near, and around the areas of natural discharge so that any subsurface outflow losses could be reduced and any evapotranspiration losses stopped with a minimum of water-level drawdown in the pumped wells; (2) in general, water levels would be lowered to and stabilized at a minimum depth of 50 feet below the land surface in areas of phreatophyte growth, which would curtail virtually all evapotranspiration losses from the ground-water reservoir; (3) long-term pumping would cause a moderately uniform depletion of storage throughout the valley-fill reservoir, except possibly in the very fine-grained playa deposits where transmissibility and storage coefficients are small and therefore storage depletion also would be small or occur over a very long period of time; (4) the specific yield of the valley fill is 10 percent; (5) water levels are within the range of economic pumping lift for the intended use; (6) the pumping development causes little or no effect on adjacent valleys and only small quantities of water are withdrawn from the adjacent consolidated-rock mountain masses; and (7) the water is of suitable chemical quality for the desired use.

To meet the needs of an emergency or other special purpose requiring ground-water pumpage in excess of the perennial yield for specified periods of time, the transitional storage reserves would be depleted at a more rapid rate than in the example given. The above equation can be used to compute the time required to exhaust the storage reserve for any selected pumping rate in excess of the perennial yield. However, once the transitional storage reserve was exhausted, the pumping rate should be reduced to the perennial yield as soon thereafter as possible. Pumpage in excess of the perennial yield would result in an overdraft, and pumping lifts would continue to increase and stored water would continue to be depleted until some undesired result occurred.

Table 15.--Records of selected wells

Owner or name: BLM, U.S. Bureau of Land Management
Use: D, domestic S, stock U, unused
State log number: Log number in the files of the Nevada State Engineer

Well number	Owner or name	Year drilled	Depth (feet)	Diameter (inches)	Use	Yield (gpm) and drawdown (feet)	Altitude of land surface (feet above mean sea level)	Water-level measurement: Date	Water-level measurement: Depth to water table (feet below land surface)	Nevada State log number
19/61-30b1	BLM	1966	270	8	S	---	6,800	8-15-67	198.10	9038
20/61-6d1	Uhalde - White Sage well	---	---	8	S	---	6,295	8-15-67	150.92	---
20/61-14d1	Gulf Oil Corp.	1965	105	6	U	---	6,240	12- -65	a 65	8830 8804
21/61-6c1	B. Paris	---	---	6	S	---	6,170	8-17-67	66.75	---
22/60-26a1	B. Paris	1925±	---	6	S	---	6,190	8-17-67	65.16	---
22/61-6c1	B. Paris - Ryegrass well	---	185	6-8	S	---	6,190	6-26-58	38.54	---
b 22/61-15	B. Paris	---	36	---	U	---	7,400	6-30-58	32.0	---
b 22/61-33	B. Paris	---	12.3	---	S	---	6,690	7- 8-58	10.5	---
23/60-22b1	BLM - West Butte well	---	105	6	S	25/---	6,255	8-17-67	54.81	9242
23/61-7d1	B. Paris	---	40	6-8	S	---	6,280	8-16-67	27.36	---
b 23/61-13	B. Paris	---	10	---	U	---	7,615	---	a 10	---
24/60-33b1	BLM - Warren Robison well	1966	420	---	U	Dry hole	---	8- -66	---	9258
24/61-14c1	B. Paris	---	---	4-6	S	---	6,320	8-16-67	53.65	---
25/62-17b1	B. Paris - Nine Mile well	---	---	---	S	---	6,300	8-16-67	9.15	---
26/62-22a1	B. Paris - Stratton Ranch well	---	---	---	D,S	---	6,390	8-19-67	15.25	---
29/62-23b1	Don Christianson	1950	54	6	D	200+/---	6,190	8-19-67	43.10	1279

Table 16.--Available drillers' logs of wells

Material	Thickness (feet)	Depth (feet)
19/61-30b1		
Clay, brown	50	50
Rock, volcanic	40	90
Sand, gray	20	110
Sand and clay	20	130
Gravel, water-bearing	140	270
20/61-14d1		
Topsoil	12	12
Sand and gravel	4	16
Clay	34	50
Cemented	5	55
Clay	30	85
Gravel, water-bearing	20	105
23/60-22b1		
Unknown	85	85
Sand	5	90
Gravel, water-bearing	15	105
24/60-33b1 (dry hole)		
Clay and gravel	40	40
Limestone	380	420

Material	Thickness (feet)	Depth (feet)
29/62-23b1		
Gravel and soil	4	4
Rock and yellow clay	16	20
Rock, loose, and dry gravel	4	24
Rock, lime	12	36
Gravel, loose	2	38
Quartz	12	50
Gravel, water-bearing	2	52
Quartz	2	54
30/62-18c1		
Gravel, cemented	90	90
Clay, sandy	5	95
Sand and gravel, water-bearing	15	110
30/63-31b1		
Clay, yellow	42	42
Gravel, sand, and clay	23	65
Gravel and sand, water-bearing	59	124

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	Bedell Flat	Sun
	Antelope	
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	Painters Flat	
	Skedaddle Creek	
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	Sano	

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ona Army Map Service 1:250,000 Scale
Elko (1958) and Ely (1956)

Hydrology by Patrick A. Glancy 1968. Geology partly synthesized and modified from Harlow (1956), Fritz (1960), and Tagg and others (1964).